WHAT IS CLAIMED IS:

1.   A radiofrequency (RF) resonator for magnetic resonance analysis, the RF resonator comprising:

(a)   at least two conductive elements, each having a first curvature along a direction perpendicular to a longitudinal axis, said at least two conductive elements being spaced along said longitudinal axis, so that when an RF current flows within said at least two conductive elements in a direction of said longitudinal axis, a substantially homogenous RF magnetic field, directed perpendicular to said longitudinal axis, is produced in a volume defined between said at least two conductive elements; and

(b)   an electronic circuitry designed and configured for providing predetermined resonance characteristics of the RF resonator, for matching an impedance of the RF resonator to an impedance of an RF transmitter electrically communicating with said electronic circuitry, and for balancing said RF magnetic field to have a substantially symmetrical profile with respect to a transverse axis being perpendicular to said longitudinal axis.

2.   The RF resonator of claim 1, further comprising a balancing adjuster electrically communicating with said electronic circuitry, said balancing adjuster is constructed and designed for controlling said electronic circuitry while the RF resonator is in medical use.

3.   The RF resonator of claim 1, further comprising at least one additional conductive element positioned so as to further minimize inhomogeneity of said magnetic field.

4.   The RF resonator of claim 3, wherein a phase of an RF current flowing through said at least one additional conductive element equals a phase of said RF currents flowing through said at least two conductive elements.

5. The RF resonator of claim 3, wherein an RF current flowing through said at least one additional conductive element depends on said RF currents flowing through said at least two conductive elements, through a predetermined function.

6. The RF resonator of claim 5, wherein said predetermined function is selected from the group consisting of a linear function, a polynomial function, an exponential function, a rational function, a power function and any combination thereof.

7. The RF resonator of claim 3, wherein an RF current flowing through said at least one additional conductive element is a predetermined fraction of said RF currents flowing through said at least two conductive elements.

8. The RF resonator of claim 7, wherein said predetermined fraction is one half.

9. The RF resonator of claim 1, wherein said electronic circuitry comprises means for varying mutual capacitance.

10. The RF resonator of claim 1, wherein said electronic circuitry comprises means for varying mutual inductance.

11. The RF resonator of claim 10, wherein said mutual inductance is defined between the RF resonator and said RF transmitter.

12. The RF resonator of claim 10, wherein said mutual inductance is defined between said electronic circuitry and said RF transmitter.

13. The RF resonator of claim 1, wherein said electronic circuitry comprises an arrangement of capacitors, inductors, tunable capacitors and tunable inductors.

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14.   The RF resonator of claim 13, wherein said capacitors and said tunable capacitors are high power capacitors.

15.   The RF resonator of claim 14, wherein said high power capacitors are vacuum capacitors.

16.   The RF resonator of claim 1, wherein a longitudinal dimension of said at least two conductive elements is selected so as to minimize magnetic field inhomogeneities along said longitudinal axis.

17.   The RF resonator of claim 1, wherein a separation between said at least two conductive elements is selected so as to surround an object to be imaged.

18.   The RF resonator of claim 17, wherein said object is a mammal.

19.   The RF resonator of claim 17, wherein said object is an organ of a mammal.

20.   The RF resonator of claim 17, wherein said object is a tissue.

21.   The RF resonator of claim 17, wherein said object is a swollen elastomer.

22.   The RF resonator of claim 17, wherein said object is a food material.

23.   The RF resonator of claim 17, wherein said object is liquid.

24.   The RF resonator of claim 17, wherein said object is at least one type of molecules present in a solvent.

25.   The RF resonator of claim 24, wherein said at least one type of molecules present in said solvent is selected from the group consisting of molecule

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dissolved in said solvent, a molecule dispersed in said solvent and a molecule emulsed in said solvent.

26.   The RF resonator of claim 1, wherein said first curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

27.   The RF resonator of claim 1, wherein at least one of said at least two conductive elements further has a second curvature along a direction parallel to said longitudinal axis.

28.   The RF resonator of claim 27, wherein said first curvature and said second curvature are each independently constant curvatures.

29.   The RF resonator of claim 27, wherein said first curvature and said second curvature are each independently variable curvatures.

30.   The RF resonator of claim 27, wherein said second curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

31.   The RF resonator of claim 1, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is linearly polarized.

32.   The RF resonator of claim 1, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is substantially circularly polarized.

33.   The RF resonator of claim 1, wherein said at least two conductive elements are two conductive elements.

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34.   The RF resonator of claim 1, wherein said at least two conductive elements are four conductive elements.

35.   The RF resonator of claim 34, wherein a first pair of said four conductive elements is electrically decoupled from a second pair of said four conductive elements.

36.   The RF resonator of claim 34, wherein a first pair of said four conductive elements is magnetically decoupled from a second pair of said four conductive elements.

37.   The RF resonator of claim 34, wherein a first pair of said four conductive elements is electromagnetically decoupled from a second pair of said four conductive elements.

38.   The RF resonator of claim 34, wherein a first pair and a second pair of said four conductive elements are positioned so that a transverse axis of said first pair is substantially perpendicular to a transverse axis of said second pair.

39.   The RF resonator of claim 1, wherein said at least two conductive elements are made of a superconducting material.

40.   The RF resonator of claim 39, further comprising means for preserving said at least two conductive elements at a sufficiently low temperature.

41.   The RF resonator of claim 1, wherein said at least two conductive elements are designed and constructed to minimize eddy currents generated therein.

42.   The RF resonator of claim 1, wherein said at least two conductive elements are characterized by an RF shield structure, for substantially blocking RF radiation while transmitting low frequency radiation.

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43.   A method of designing a radiofrequency (RF) resonator for magnetic resonance analysis, the method comprising:

(a)   selecting at least two surfaces to engage at least two conductive elements, said at least two surfaces having a first curvature along a direction perpendicular to a longitudinal axis, thereby defining a geometry between said at least two surfaces;

(b)   using said geometry for calculating a magnetic field within said geometry;

(c)   iteratively repeating said steps (a) and (b) so as to provide optimized geometry corresponding to a substantially homogenous magnetic field; and

(d)   using said optimized geometry and said substantially homogenous magnetic field for designing an electronic circuitry for providing predetermined resonance characteristics of the RF resonator, for matching an impedance of the RF resonator to an impedance of an RF transmitter electrically communicating with said electronic circuitry, and for balancing said RF magnetic field to have a substantially symmetrical profile with respect to a transverse axis being perpendicular to said longitudinal axis.

44.   The method of claim 43, wherein said matching is by varying mutual capacitance.

45.   The method of claim 43, wherein said matching is by varying mutual inductance.

46.   The method of claim 45, wherein said mutual inductance is defined between the RF resonator and said RF transmitter.

47.   The method of claim 45, wherein said mutual inductance is defined between said electronic circuitry and said RF transmitter.

48.   The method of claim 43, wherein a longitudinal dimension of said at least two conductive elements is selected so as to minimize magnetic field inhomogeneities along said longitudinal axis.

49.   The method of claim 43, wherein said calculating said magnetic field within said geometry is by solving Maxwell's equations.

50.   The method of claim 43, wherein said calculating said magnetic field within said geometry is by finite element method.

51.   The method of claim 43, wherein said calculating said magnetic field within said geometry is by moments analysis method.

52.   The method of claim 43, wherein a separation between said at least two conductive elements is selected so as to surround an object to be imaged.

53.   The method of claim 52, wherein said object is a mammal.

54.   The method of claim 52, wherein said object is an organ of a mammal.

55.   The method of claim 52, wherein said object is a tissue.

56.   The method of claim 52, wherein said object is a swollen elastomer.

57.   The method of claim 52, wherein said object is a food material.

58.   The method of claim 52, wherein said object is liquid.

59.   The method of claim 52, wherein said object is at least one type of molecules present in the solvent.

60.   The method of claim 59, wherein said at least one type of molecules present in said solvent is selected from the group consisting of molecule dissolved in

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said solvent, a molecule dispersed in said solvent and a molecule emulsed in said solvent.

61.   The method of claim 43, further comprising designing an RF shield for minimizing electromagnetic interactions between the RF resonator and at least one gradient coil and/or between the RF resonator and a device for providing a static magnetic field.

62.   The method of claim 61, wherein said designing an RF shield is by the method of images.

63.   The method of claim 43, further comprising designing at least one end-cap to be positioned adjacent to at least one end of the RF resonator for minimizing magnetic field inhomogeneities along said longitudinal axis.

64.   The method of claim 43, wherein said first curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

65.   The method of claim 43, wherein at least one of said at least two surfaces further has a second curvature along a direction parallel to said longitudinal axis.

66.   The method of claim 65, wherein said first curvature and said second curvature are each independently constant curvatures.

67.   The method of claim 65, wherein said first curvature and said second curvature are each independently variable curvatures.

68.   The method of claim 65, wherein said second curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

69.   The method of claim 43, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is linearly polarized.

70.   The method of claim 43, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is substantially circularly polarized.

71.   The method of claim 43, wherein said at least two conductive elements are two conductive elements.

72.   The method of claim 43, wherein said at least two conductive elements are four conductive elements.

73.   The method of claim 72, further comprising decoupling a first pair of said four conductive elements from a second pair of said four conductive elements.

74.   The method of claim 72, further comprising magnetically decoupling a first pair of said four conductive elements from a second pair of said four conductive elements.

75.   The method of claim 72, further comprising electrically decoupling a first pair of said four conductive elements from a second pair of said four conductive elements.

76.   The method of claim 72, further comprising electromagnetically decoupling a first pair of said four conductive elements from a second pair of said four conductive elements.

77.   The method of claim 72, wherein a first pair and a second pair of said four conductive elements are positioned so that a transverse axis of said first pair is substantially perpendicular to a transverse axis of said second pair.

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78.   The method of claim 43, further comprising designing at least one additional conductive element, so as to further minimize inhomogeneity of said magnetic field.

79.   The method of claim 78, wherein a phase of an RF current flowing through said at least one additional conductive element equals a phase of currents flowing through said at least two conductive elements.

80.   The method of claim 78, wherein an RF current flowing through said at least one additional conductive element depends on currents flowing through said at least two conductive elements, through a predetermined function.

81.   The method of claim 80, wherein said predetermined function is selected from the group consisting of a linear function, a polynomial function, an exponential function, a rational function, a power function and any combination thereof.

82.   The method of claim 78, wherein an RF current flowing through said at least one additional conductive element is a predetermined fraction of currents flowing through said at least two conductive elements.

83.   The method of claim 82, wherein said predetermined fraction is one half.

84.   The method of claim 43, wherein said at least two conductive elements are designed and constructed to minimize eddy currents generated therein.

85.   The method of claim 43, wherein said at least two conductive elements are characterized by an RF shield structure for substantially blocking RF radiation while transmitting low frequency radiation.

86.   An apparatus for magnetic resonance analysis, the apparatus comprising:

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(a)   a device for providing a static magnetic field;

(b)   a processing unit; and

(c)   a radiofrequency (RF) resonator coupled to an RF transmitter, said RF resonator comprising:

at least two conductive elements, each having a first curvature along a direction perpendicular to a longitudinal axis, said at least two conductive elements being spaced along said longitudinal axis, so that when an RF current flows within said at least two conductive elements in a direction of said longitudinal axis, a substantially homogenous RF magnetic field, directed perpendicular to said longitudinal axis, is produced in a volume defined between said at least two conductive elements; and

an electronic circuitry designed and configured for providing predetermined resonance characteristics of said RF resonator, for matching an impedance of said RF resonator to an impedance of said RF transmitter, and for balancing said RF magnetic field to have a substantially symmetrical profile with respect to a transverse axis being perpendicular to said longitudinal axis.

87.   The apparatus of claim 86, wherein said RF resonator further comprising a balancing adjuster electrically communicating with said electronic circuitry, said balancing adjuster is constructed and designed for controlling said electronic circuitry while resonator is in medical use.

88.   The apparatus of claim 86, wherein said RF resonator further comprising at least one additional conductive element positioned so as to further minimize inhomogeneity of said magnetic field.

89.   The apparatus of claim 88, wherein a phase of an RF current flowing through said at least one additional conductive element equals a phase of said RF currents flowing through said at least two conductive elements.

90.   The apparatus of claim 88, wherein an RF current flowing through said at least one additional conductive element depends on said RF currents flowing through said at least two conductive elements, through a predetermined function.

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91.   The apparatus of claim 90, wherein said predetermined function is selected from the group consisting of a linear function, a polynomial function, an exponential function, a rational function, a power function and any combination thereof.

92.   The apparatus of claim 88, wherein an RF current flowing through said at least one additional conductive element is a predetermined fraction of said RF currents flowing through said at least two conductive elements.

93.   The apparatus of claim 92, wherein said predetermined fraction is one half.

94.   The apparatus of claim 86, wherein said device for providing said static magnetic field comprises at least one shim coil.

95.   The apparatus of claim 86, further comprising at least one gradient coil.

96.   The apparatus of claim 95, further comprising an RF shield constructed and designed for minimizing electromagnetic interactions between said at least one gradient coil and said device for providing a static magnetic field.

97.   The apparatus of claim 86, further comprising at least one end-cap positioned adjacent to at least one end of said RF resonator, said at least one end-cap constructed and designed for minimizing magnetic field inhomogeneities along said longitudinal axis.

98.   The apparatus of claim 86, wherein said RF resonator is coupled to said RF transmitter via a transmission line.

99.   The apparatus of claim 86, wherein said RF resonator is coupled to said RF transmitter via an RF antenna.

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100.   The apparatus of claim 98, wherein said electronic circuitry comprises means for varying mutual capacitance.

101.   The apparatus of claim 98, wherein said electronic circuitry comprises means for varying mutual inductance.

102.   The apparatus of claim 101, wherein said mutual inductance is defined between said RF resonator and said RF transmitter.

103.   The apparatus of claim 101, wherein said mutual inductance is defined between said electronic circuitry and said RF transmitter.

104.   The apparatus of claim 86, wherein said electronic circuitry comprises an arrangement of capacitors, inductors, tunable capacitors and tunable inductors.

105.   The apparatus of claim 104, wherein said capacitors and said tunable capacitors are high power capacitors.

106.   The apparatus of claim 105, wherein said high power capacitors are vacuum capacitors.

107.   The apparatus of claim 86, wherein a longitudinal dimension of said at least two conductive elements is selected so as to minimize magnetic field inhomogeneities along said longitudinal axis.

108.   The apparatus of claim 86, wherein a separation between said at least two conductive elements is selected so as to surround an object to be imaged.

109.   The apparatus of claim 108, wherein said object is a mammal.

110.   The apparatus of claim 108, wherein said object is an organ of a mammal.

111.   The apparatus of claim 108, wherein said object is a tissue.

112.   The apparatus of claim 108, wherein said object is a swollen elastomer.

113.   The apparatus of claim 108, wherein said object is a food material.

114.   The apparatus of claim 108, wherein said object is liquid.

115.   The apparatus of claim 108, wherein said object is at least one type of molecules present in the solvent.

116.   The apparatus of claim 115, wherein said at least one type of molecules present in said solvent is selected from the group consisting of molecule dissolved in said solvent, a molecule dispersed in said solvent and a molecule emulsed in said solvent.

117.   The apparatus of claim 86, wherein said first curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

118.   The apparatus of claim 86, wherein at least one of said at least two conductive elements further has a second curvature along a direction parallel to said longitudinal axis.

119.   The apparatus of claim 118, wherein said first curvature and said second curvature are each independently constant curvatures.

120.   The apparatus of claim 118, wherein said first curvature and said second curvature are each independently variable curvatures.

121.   The apparatus of claim 118, wherein said second curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a

curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

122.   The apparatus of claim 86, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is linearly polarized.

123.   The apparatus of claim 86, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is substantially circularly polarized.

124.   The apparatus of claim 86, wherein said at least two conductive elements are two conductive elements.

125.   The apparatus of claim 86, wherein said at least two conductive elements are four conductive elements.

126.   The apparatus of claim 125, wherein a first pair of said four conductive elements is electrically decoupled from a second pair of said four conductive elements.

127.   The apparatus of claim 125, wherein a first pair of said four conductive elements is magnetically decoupled from a second pair of said four conductive elements.

128.   The apparatus of claim 125, wherein a first pair of said four conductive elements is electrically decoupled from a second pair of said four conductive elements.

129.   The apparatus of claim 125, wherein a first pair of said four conductive elements is electromagnetically decoupled from a second pair of said four conductive elements.

130.   The apparatus of claim 125, wherein a first pair and a second pair of said four conductive elements are positioned so that a transverse axis of said first pair is substantially perpendicular to a transverse axis of said second pair.

131.   The apparatus of claim 86, wherein said at least two conductive elements are made of a superconducting material.

132.   The apparatus of claim 131, further comprising means for preserving said at least two conductive elements at a sufficiently low temperature.

133.   The apparatus of claim 131, further comprising at least one additional RF resonator arranged with said RF resonator to form an RF resonator array.

134.   The apparatus of claim 133, further comprising decoupling means for decoupling said RF resonator from said at least one additional RF resonator.

135.   The apparatus of claim 95, further comprising decoupling means for decoupling said RF resonator from said at least one gradient coil.

136.   The apparatus of claim 135, wherein said decoupling means comprise DC block capacitors.

137.   The apparatus of claim 133, wherein said array is a phased array.

138.   The apparatus of claim 131, wherein said RF resonator is a multi frequency RF resonator.

139.   The apparatus of claim 131, wherein each of said at least two conductive elements has a predetermined capacitance distribution for minimizing effects of an object to be imaged on said magnetic field and for minimizing corona discharge from said at least two conductive elements.

140.   The apparatus of claim 86, wherein said at least two conductive elements are designed and constructed to minimize eddy currents generated therein.

141.   The apparatus of claim 86, wherein said at least two conductive elements are characterized by an RF shield structure for substantially blocking RF radiation while transmitting low frequency radiation.

142.   A method for Magnetic Resonance analysis of an object, the method comprising:

applying a static magnetic field on the subject in a direction of a longitudinal axis;

applying a substantially homogenous radiofrequency (RF) magnetic field on the subject, in a direction perpendicular to said longitudinal axis; and

acquiring nuclear magnetic resonance parameters from the object, thereby analyzing the object;

wherein said applying said substantially homogenous RF magnetic field is by a RF resonator coupled to an RF transmitter, said RF resonator comprising:

at least two conductive elements, each having a first curvature along a direction perpendicular to said longitudinal axis, said at least two conductive elements being spaced along said longitudinal axis, so that when an RF current flows within said at least two conductive elements in a direction of said longitudinal axis, said substantially homogenous RF magnetic field, is produced in a volume defined between said at least two conductive elements; and

an electronic circuitry designed and configured for providing predetermined resonance characteristics of the RF resonator, for matching an impedance of the RF resonator to an impedance of an RF transmitter electrically communicating with said electronic circuitry, and for balancing said RF magnetic field to have a substantially symmetrical profile with respect to a transverse axis being perpendicular to said longitudinal axis.

143.   The method of claim 1, further comprising balancing said RF magnetic field using a balancing adjuster electrically communicating with said electronic circuitry.

144. The method of claim 142, wherein said RF resonator further comprising at least one additional conductive element positioned so as to further minimize inhomogeneity of said magnetic field.

145. The method of claim 144, wherein a phase of an RF current flowing through said at least one additional conductive element equals a phase of said RF current flowing through said at least two conductive elements.

146. The method of claim 144, wherein an RF current flowing through said at least one additional conductive element depends on said RF currents flowing through said at least two conductive elements, through a predetermined function.

147. The method of claim 146, wherein said predetermined function is selected from the group consisting of a linear function, a polynomial function, an exponential function, a rational function, a power function and any combination thereof.

148. The method of claim 144, wherein an RF current flowing through said at least one additional conductive element is a predetermined fraction of said RF currents flowing through said at least two conductive elements.

149. The method of claim 148, wherein said predetermined fraction is one half.

150. The method of claim 142, further comprising applying at least one gradient pulse on the object.

151. The method of claim 142, wherein said RF resonator is coupled to said RF transmitter via a transmission line.

152. The method of claim 142, wherein said RF resonator is coupled to said RF transmitter via an RF antenna.

153.   The method of claim 142, wherein said electronic circuitry comprises means for varying mutual capacitance.

154.   The method of claim 142, wherein said electronic circuitry comprises means for varying mutual inductance.

155.   The method of claim 153, wherein said mutual inductance is defined between said RF resonator and said RF transmitter.

156.   The method of claim 153, wherein said mutual inductance is defined between said electronic circuitry and said RF transmitter.

157.   The method of claim 142, wherein said electronic circuitry comprises an arrangement of capacitors, inductors, tunable capacitors and tunable inductors.

158.   The method of claim 157, wherein said capacitors and said tunable capacitors are high power capacitors.

159.   The method of claim 158, wherein said high power capacitors are vacuum capacitors.

160.   The method of claim 142, wherein a longitudinal dimension of said at least two conductive elements is selected so as to minimize magnetic field inhomogeneities along said longitudinal axis.

161.   The method of claim 142, wherein a separation between said at least two conductive elements is selected so as to surround the object.

162.   The method of claim 142, wherein the object is a mammal.

163.   The method of claim 142, wherein the object is an organ of a mammal.

164.   The method of claim 142, wherein the object is a tissue.

165.   The method of claim 142, wherein the object is a swollen elastomer.

166.   The method of claim 142, wherein the object is a food material.

167.   The method of claim 142, wherein said first curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

168.   The method of claim 142, wherein at least one of said at least two conductive elements further has a second curvature along a direction parallel to said longitudinal axis.

169.   The method of claim 168, wherein said first curvature and said second curvature are each independently constant curvatures.

170.   The method of claim 168, wherein said first curvature and said second curvature are each independently variable curvatures.

171.   The method of claim 168, wherein said second curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

172.   The method of claim 142, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is linearly polarized.

173.   The method of claim 142, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is substantially circularly polarized.

174.   The method of claim 142, wherein said at least two conductive elements are two conductive elements.

175.   The method of claim 142, wherein said at least two conductive elements are four conductive elements.

176.   The method of claim 175, wherein a first pair of said four conductive elements is electrically decoupled from a second pair of said four conductive elements.

177.   The method of claim 175, wherein a first pair of said four conductive elements is magnetically decoupled from a second pair of said four conductive elements.

178.   The method of claim 175, wherein a first pair of said four conductive elements is electrically decoupled from a second pair of said four conductive elements.

179.   The method of claim 175, wherein a first pair of said four conductive elements is electromagnetically decoupled from a second pair of said four conductive elements.

180.   The method of claim 175, wherein a first pair and a second pair of said four conductive elements are positioned so that a transverse axis of said first pair is substantially perpendicular to a transverse axis of said second pair.

181.   The method of claim 142, wherein said at least two conductive elements are made of a superconducting material.

182.   The method of claim 181, further comprising preserving said at least two conductive elements at a sufficiently low temperature.

183.   The method of claim 181, wherein said applying said substantially homogenous RF magnetic field is by at least one additional RF resonator.

184.   The method of claim 181, wherein said at least one additional RF resonator is arranged with said RF resonator to form an RF resonator array.

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185.   The method of claim 183, further comprising electrically decoupling said RF resonator from said at least one additional RF resonator.

186.   The method of claim 183, further comprising electromagnetically decoupling said RF resonator from said at least one additional RF resonator.

187.   The method of claim 183, wherein said array is a phased array.

188.   The method of claim 181, wherein said RF resonator is a multi frequency RF resonator.

189.   The method of claim 181, wherein each of said at least two conductive elements has a predetermined capacitance distribution for minimizing effects of the object on said magnetic field and for minimizing corona discharge from said at least two conductive elements.

190.   The method of claim 142, wherein said at least two conductive elements are designed and constructed to minimize eddy currents generated therein.

191.   The method of claim 142, wherein said at least two conductive elements are characterized by an RF shield structure for substantially blocking RF radiation while transmitting low frequency radiation.

192.   A radiofrequency (RF) resonator for magnetic resonance analysis, the RF resonator comprising:

(a)   at least two conductive elements, each having a first curvature along a direction perpendicular to a longitudinal axis, said at least two conductive elements being spaced along said longitudinal axis, so that when an RF current flows within said at least two conductive elements in a direction of said longitudinal axis, a substantially homogenous RF magnetic field, directed perpendicular to said longitudinal axis, is produced in a volume defined between said at least two conductive elements; and

(b)   at least one additional conductive element, electrically communicating with said at least two conductive elements in a manner such that a phase of an RF current flowing through said at least one additional conductive element equals a phase of at least one of said RF currents flowing through said at least two conductive elements.

193.   The RF resonator of claim 192, further comprising an electronic circuitry designed and configured for providing predetermined resonance characteristics of the RF resonator, for matching an impedance of the RF resonator to an impedance of an RF transmitter electrically communicating with said electronic circuitry, and for balancing said RF magnetic field to have a substantially symmetrical profile with respect to a transverse axis being perpendicular to said longitudinal axis.

194.   The RF resonator of claim 193, further comprising a balancing adjuster electrically communicating with said electronic circuitry, said balancing adjuster is constructed and designed for controlling said electronic circuitry while the RF resonator is in medical use.

195.   The RF resonator of claim 192, wherein an RF current flowing through said at least one additional conductive element depends on said RF currents flowing through said at least two conductive elements, through a predetermined function.

196.   The RF resonator of claim 195, wherein said predetermined function is selected from the group consisting of a linear function, a polynomial function, an exponential function, a rational function, a power function and any combination thereof.

197.   The RF resonator of claim 192, wherein an RF current flowing through said at least one additional conductive element is a predetermined fraction of said RF currents flowing through said at least two conductive elements.

198.   The RF resonator of claim 197, wherein said predetermined fraction is one half.

199.   The RF resonator of claim 193, wherein said electronic circuitry comprises means for varying mutual capacitance.

200.   The RF resonator of claim 193, wherein said electronic circuitry comprises means for varying mutual inductance.

201.   The RF resonator of claim 200, wherein said mutual inductance is defined between the RF resonator and said RF transmitter.

202.   The RF resonator of claim 200, wherein said mutual inductance is defined between said electronic circuitry and said RF transmitter.

203.   The RF resonator of claim 193, wherein said electronic circuitry comprises an arrangement of capacitors, inductors, tunable capacitors and tunable inductors.

204.   The RF resonator of claim 203, wherein said capacitors and said tunable capacitors are high power capacitors.

205.   The RF resonator of claim 204, wherein said high power capacitors are vacuum capacitors.

206.   The RF resonator of claim 192, wherein a longitudinal dimension of said at least two conductive elements is selected so as to minimize magnetic field inhomogeneities along said longitudinal axis.

207.   The RF resonator of claim 192, wherein a separation between said at least two conductive elements is selected so as to surround an object to be imaged.

208.   The RF resonator of claim 207, wherein said object is a mammal.

209.   The RF resonator of claim 207, wherein said object is an organ of a mammal.

210.   The RF resonator of claim 207, wherein said object is a tissue.

211.   The RF resonator of claim 207, wherein said object is a swollen elastomer.

212.   The RF resonator of claim 207, wherein said object is a food material.

213.   The RF resonator of claim 207, wherein said object is liquid.

214.   The RF resonator of claim 207, wherein said object is at least one type of molecules present in a solvent.

215.   The RF resonator of claim 214, wherein said at least one type of molecules present in said solvent is selected from the group consisting of molecule dissolved in said solvent, a molecule dispersed in said solvent and a molecule emulsed in said solvent.

216.   The RF resonator of claim 192, wherein said first curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

217.   The RF resonator of claim 192, wherein at least one of said at least two conductive elements further has a second curvature along a direction parallel to said longitudinal axis.

218.   The RF resonator of claim 217, wherein said first curvature and said second curvature are each independently constant curvatures.

219.   The RF resonator of claim 217, wherein said first curvature and said second curvature are each independently variable curvatures.

220.   The RF resonator of claim 217, wherein said second curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

221.   The RF resonator of claim 192, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is linearly polarized.

222.   The RF resonator of claim 192, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is substantially circularly polarized.

223.   The RF resonator of claim 192, wherein said at least two conductive elements are two conductive elements.

224.   The RF resonator of claim 192, wherein said at least two conductive elements are four conductive elements.

225.   The RF resonator of claim 224, wherein a first pair of said four conductive elements is electrically decoupled from a second pair of said four conductive elements.

226.   The RF resonator of claim 224, wherein a first pair of said four conductive elements is magnetically decoupled from a second pair of said four conductive elements.

227.   The RF resonator of claim 224, wherein a first pair of said four conductive elements is electromagnetically decoupled from a second pair of said four conductive elements.

228.   The RF resonator of claim 224, wherein a first pair and a second pair of said four conductive elements are positioned so that a transverse axis of said first pair is substantially perpendicular to a transverse axis of said second pair.

229.   The RF resonator of claim 192, wherein said at least two conductive elements are made of a superconducting material.

230.   The RF resonator of claim 229, further comprising means for preserving said at least two conductive elements at a sufficiently low temperature.

231.   An apparatus for magnetic resonance analysis, the apparatus comprising:

(a)   a device for providing a static magnetic field;

(b)   a processing unit; and

(c)   a radiofrequency (RF) resonator coupled to an RF transmitter, said RF resonator comprising:

at least two conductive elements, each having a first curvature along a direction perpendicular to a longitudinal axis, said at least two conductive elements being spaced along said longitudinal axis, so that when an RF current flows within said at least two conductive elements in a direction of said longitudinal axis, a substantially homogenous RF magnetic field, directed perpendicular to said longitudinal axis, is produced in a volume defined between said at least two conductive elements; and

at least one additional conductive element, electrically communicating with said at least two conductive elements in a manner such that a phase of an RF current flowing through said at least one additional conductive element equals a phase of at least one of said RF currents flowing through said at least two conductive elements.

232.   The apparatus of claim 231, wherein said RF resonator further comprising an electronic circuitry designed and configured for providing predetermined resonance characteristics of said RF resonator, for matching an impedance of said RF resonator to an impedance of said RF transmitter, and for balancing said RF magnetic field to have a substantially symmetrical profile with respect to a transverse axis being perpendicular to said longitudinal axis.

233.   The apparatus of claim 232, wherein said RF resonator further comprising a balancing adjuster electrically communicating with said electronic circuitry, said balancing adjuster is constructed and designed for controlling said electronic circuitry while said RF resonator is in medical use.

234.   The apparatus of claim 231, wherein an RF current flowing through said at least one additional conductive element depends on said RF currents flowing through said at least two conductive elements, through a predetermined function.

235.   The apparatus of claim 234, wherein said predetermined function is selected from the group consisting of a linear function, a polynomial function, an exponential function, a rational function, a power function and any combination thereof.

236.   The apparatus of claim 231, wherein an RF current flowing through said at least one additional conductive element is a predetermined fraction of said RF currents flowing through said at least two conductive elements.

237.   The apparatus of claim 236, wherein said predetermined fraction is one half.

238.   The apparatus of claim 231, wherein said device for providing said static magnetic field comprises at least one shim coil.

239.   The apparatus of claim 231, further comprising at least one gradient coil.

240.   The apparatus of claim 239, further comprising an RF shield constructed and designed for minimizing electromagnetic interactions between said at least one gradient coil and said device for providing a static magnetic field.

241.   The apparatus of claim 231, further comprising at least one end-cap positioned adjacent to at least one end of said RF resonator, said at least one end-cap

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constructed and designed for minimizing magnetic field inhomogeneities along said longitudinal axis.

242.   The apparatus of claim 232, wherein said RF resonator is coupled to said RF transmitter via a transmission line.

243.   The apparatus of claim 232, wherein said RF resonator is coupled to said RF transmitter via an RF antenna.

244.   The apparatus of claim 232, wherein said electronic circuitry comprises means for varying mutual capacitance.

245.   The apparatus of claim 232, wherein said electronic circuitry comprises means for varying mutual inductance.

246.   The apparatus of claim 245, wherein said mutual inductance is defined between said RF resonator and said RF transmitter.

247.   The apparatus of claim 245, wherein said mutual inductance is defined between said electronic circuitry and said RF transmitter.

248.   The apparatus of claim 232, wherein said electronic circuitry comprises an arrangement of capacitors, inductors, tunable capacitors and tunable inductors.

249.   The apparatus of claim 248, wherein said capacitors and said tunable capacitors are high power capacitors.

250.   The apparatus of claim 249, wherein said high power capacitors are vacuum capacitors.

251.   The apparatus of claim 231, wherein a longitudinal dimension of said at least two conductive elements is selected so as to minimize magnetic field inhomogeneities along said longitudinal axis.

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252. The apparatus of claim 231, wherein a separation between said at least two conductive elements is selected so as to surround an object to be imaged.

253. The apparatus of claim 252, wherein said object is a mammal.

254. The apparatus of claim 252, wherein said object is an organ of a mammal.

255. The apparatus of claim 252, wherein said object is a tissue.

256. The apparatus of claim 252, wherein said object is a swollen elastomer.

257. The apparatus of claim 252, wherein said object is a food material.

258. The apparatus of claim 252, wherein said object is liquid.

259. The apparatus of claim 252, wherein said object is at least one type of molecules present in the solvent.

260. The apparatus of claim 259, wherein said at least one type of molecules present in said solvent is selected from the group consisting of molecule dissolved in said solvent, a molecule dispersed in said solvent and a molecule emulsed in said solvent.

261. The apparatus of claim 231, wherein said first curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

262. The apparatus of claim 231, wherein at least one of said at least two conductive elements further has a second curvature along a direction parallel to said longitudinal axis.

263.   The apparatus of claim 262, wherein said first curvature and said second curvature are each independently constant curvatures.

264.   The apparatus of claim 262, wherein said first curvature and said second curvature are each independently variable curvatures.

265.   The apparatus of claim 262, wherein said second curvature is selected from the group consisting of a curvature of cylinder, a curvature of an ellipsoid, a curvature of a hyperboloid, a curvature of a paraboloid and a curvature of an irregular surface.

266.   The apparatus of claim 231, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is linearly polarized.

267.   The apparatus of claim 231, wherein a number of said at least two conductive elements is selected so that said substantially homogenous RF magnetic field is substantially circularly polarized.

268.   The apparatus of claim 231, wherein said at least two conductive elements are two conductive elements.

269.   The apparatus of claim 231, wherein said at least two conductive elements are four conductive elements.

270.   The apparatus of claim 269, wherein a first pair of said four conductive elements is electrically decoupled from a second pair of said four conductive elements.

271.   The apparatus of claim 269, wherein a first pair of said four conductive elements is magnetically decoupled from a second pair of said four conductive elements.

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272.   The apparatus of claim 269, wherein a first pair of said four conductive elements is electrically decoupled from a second pair of said four conductive elements.

273.   The apparatus of claim 269, wherein a first pair of said four conductive elements is electromagnetically decoupled from a second pair of said four conductive elements.

274.   The apparatus of claim 269, wherein a first pair and a second pair of said four conductive elements are positioned so that a transverse axis of said first pair is substantially perpendicular to a transverse axis of said second pair.

275.   The apparatus of claim 231, wherein said at least two conductive elements are made of a superconducting material.

276.   The apparatus of claim 275, further comprising means for preserving said at least two conductive elements at a sufficiently low temperature.

277.   The apparatus of claim 275, further comprising at least one additional RF resonator arranged with said RF resonator to form an RF resonator array.

278.   The apparatus of claim 277, further comprising decoupling means for decoupling said RF resonator from said at least one additional RF resonator.

279.   The apparatus of claim 239, further comprising decoupling means for decoupling said RF resonator from said at least one gradient coil.

280.   The apparatus of claim 279, wherein said decoupling means comprise DC block capacitors.

281.   The apparatus of claim 277, wherein said array is a phased array.

282.   The apparatus of claim 275, wherein said RF resonator is a multi frequency RF resonator.

283. The apparatus of claim 275, wherein each of said at least two conductive elements has a predetermined capacitance distribution for minimizing effects of an object to be imaged on said magnetic field and for minimizing corona discharge from said at least two conductive elements.

284. The apparatus of claim 231, wherein said at least two conductive elements are designed and constructed to minimize eddy currents generated therein.

285. The apparatus of claim 231, wherein said at least two conductive elements are characterized by an RF shield structure for substantially blocking RF radiation while transmitting low frequency radiation.